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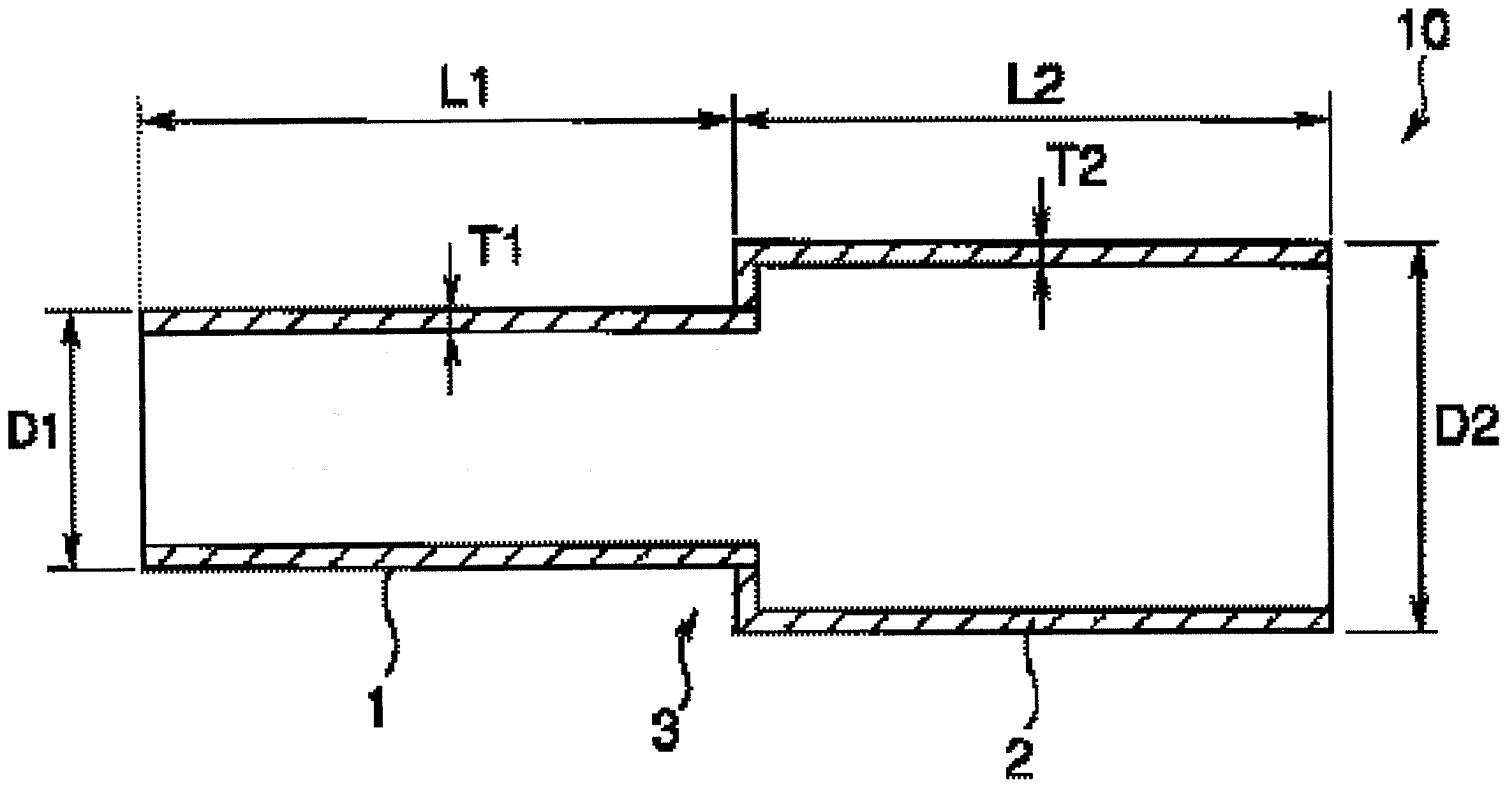

(19) (11) Publication number: **2001**

Generated Document.

PATENT ABSTRACTS OF JAPAN

(21) Application number: **2000053731**

(51) Intl. Cl.: **F16F 7/12** B60R 19/34 B60R 21/15

(22) Application date: **29.02.00**

(30) Priority:

(43) Date of application publication: **07.09.01**

(84) Designated contracting states:

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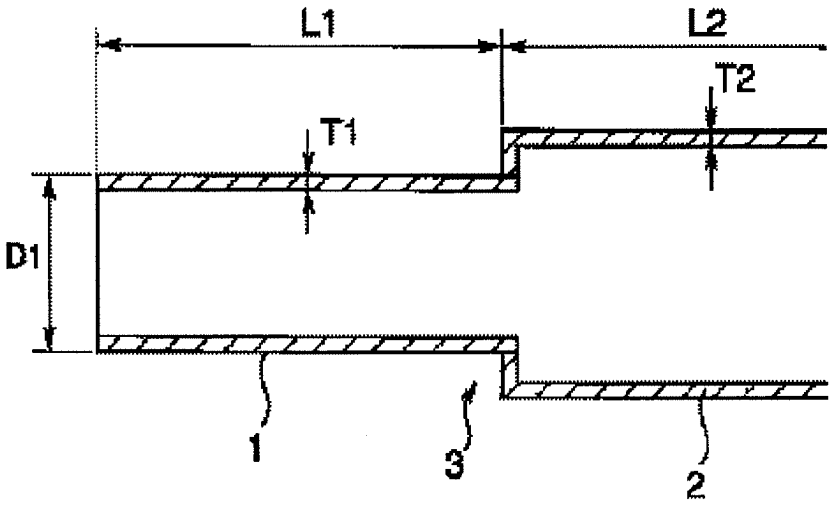
(54) COLLISION ENERGY ABSORBING STRUCTURE

(57) Abstract:

PROBLEM TO BE SOLVED: To provide a collision energy absorbing structure producing small reaction in collision, having a small reaction change in deforming a member, and exhibiting a stable performance irrelevant to the collision direction.

SOLUTION: This collision energy absorbing structure 10 is formed by coaxially integrating a first and a second cylinder member 1 and 2 having mutually different diameters together with their ends joined to each other and absorbs the collision energy by axial deformation.


L1
L2
T2
T1
D1
1
3
2

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the collision energy-absorbing structure used in order to raise collision safeties, such as an automobile.
[0002]
[Description of the Prior Art] Improvement in the safe performance of a car body has been a big technical problem against the background of regulation system strengthening of automobile collision insurance. Therefore, the automobile structural member is asked for the structure which can absorb the collision energy at the time of colliding effectively.
[0003] What absorbs collision energy by the plastic deformation of the material by what is folded up a fixed period with a member side face as collision energy-absorbing structure in an automobile structural member (Folding) is known.
[0004] With such collision energy-absorbing structure, if reaction force occurs in a structural member and the reaction force becomes the moment of a collision of an automobile beyond the buckling proof stress of a structural member, plastic deformation will be started. Then, reaction force change of a fixed period is repeated in connection with deformation of a structural member. Collision energy is absorbed according to this reaction force. Damage on other automobile structures is controlled and easing whenever [to crew / impact] further is expected by this.
[0005]
[Problem(s) to be Solved by the Invention] However, in the conventional collision energy-absorbing structure, since high buckling reaction force occurs at the moment of a collision, the danger that the impulse force will damage other structures will be high, and also whenever [to crew / impact] will become large. Moreover, in order to repeat reaction force change of a fixed period at the time of member deformation, the impulse force to crew is large. For this reason, the effectiveness of relaxation cannot say that it is enough whenever [damage control or impact]. Furthermore, the engine performance may fall depending on the direction which collides. Therefore, a reliable car-body design is difficult.
[0006] This invention aims at being made in view of this situation and offering the collision energy-absorbing structure which can demonstrate the engine performance by which it was small, and whose reaction force change at the time of member deformation was small, and the reaction force at the time of a collision was not caused in the direction which collides, but was stabilized.
[0007]
[Means for Solving the Problem] In order to solve the above-mentioned technical problem, this invention offers the collision energy-absorbing structure characterized by coming to be unified where those edges are put together in same axle, and the 1st and 2nd tubed part material from which a path differs mutually absorbing collision energy according to deformation of shaft orientations.
[0008] Since the 1st and 2nd tubed part material from which a path differs mutually has the structure unified in same axle where those edges are put together according to this invention, at the moment of colliding, the level difference section with which the 1st and 2nd tubed part

material was united carries out elastic deformation, and it is prevented that big buckling reaction force occurs by it. Moreover, when the member of a minor diameter curls outside among the 1st and 2nd tubed part material and the member of a major diameter curls inside in the level difference section at the time of member deformation, continuous plastic deformation can be generated and the stable reaction force without a periodic change can be generated. Therefore, the damage to other members in the case of a collision can be mitigated, and impulse force to crew can be made small. Moreover, since the member of a major diameter can function as a guide and can limit a motion of the member of a minor diameter only to abbreviation shaft orientations among the 1st and 2nd tubed part material, even if the collision direction changes, there is little change of a deformation condition. Therefore, the engine performance powerful [in the direction which collides] and stabilized can be demonstrated, and a reliable design is attained.

[0009] In this case, set the path of the 1st tubed part material to D1, and set board thickness to T1, and set the path of the 2nd tubed part material to D2, and board thickness is set to T2. When path clearance C is furthermore made into C=(D 2/2)-T2- (D 1/2), it is desirable to satisfy x(T1+T2) 1.2 >=C>0 and T2/T1>0.8.

[0010] Moreover, from the same material, the collision energy-absorbing structure of this invention may be formed by processing, and may join and form the 1st tubed part material and the 2nd tubed part material. Although the same quality of the material is sufficient as said 1st tubed part material and the 2nd tubed part material when forming by junction, it is more desirable to consist of the different quality of the material. Moreover, although the same board thickness is sufficient as said 1st tubed part material and the 2nd tubed part material, it is desirable that it is different board thickness.

[0011] The steel which has the ductility which level on the strength does not fracture by 270-1500MPa at the time of deformation as an ingredient which constitutes the collision energy absorption structure of this invention is desirable.

[0012]

[Embodiment of the Invention] Hereafter, with reference to an accompanying drawing, this invention is explained concretely. Drawing 1 is the sectional view showing the collision energy-absorbing structure concerning 1 operation gestalt of this invention. This collision energy-absorbing structure 10 has the 1st tubed part material 1 of a minor diameter, and the 2nd tubed part material 2 of a major diameter. The tubed part material 1 of these 1st and the 2nd tubed part material 2 are unified in same axle, where those edges are put together. And the part with which the edge with the 1st tubed part material 1 and the 2nd tubed part material 2 was united serves as the level difference section 3. In addition, as for the 1st tubed part material 1, the path is [D1 and board thickness] T1, and the path is [D2 and the board thickness of the 2nd tubed part material 2] T2.

[0013] When this collision energy-absorbing structure collides, it absorbs collision energy according to deformation of those shaft orientations. At the moment of colliding, since elastic deformation arises in the level difference section 3 with which the 1st and 2nd tubed part material 1 and 2 was united, it is specifically prevented that big buckling reaction force occurs. At the time of member deformation In the level difference section 3, when the 1st tubed part material 1 of a minor diameter curls outside and the 2nd member 2 of a major diameter curls inside, continuous plastic deformation can be generated and the stable reaction force without a periodic change can be generated. Moreover, even if the 2nd tubed part material 2 of a major diameter can function as a guide, it can limit a motion of the tubed part material 1 of a minor

diameter only to abbreviation shaft orientations and the collision direction changes, there is little change of a deformation condition.
[0014] Here, it is the path clearance C of these tubed part material 1 and 2 C=(D 2/2)-T2 - (D 1/2)
When it carries out, it is desirable to satisfy the following (1) and (2) types.
(T1+T2) x1.2>=C> 0 .... (1)
T2/T1> 0.8 .... (2)
[0015] By satisfying these formulas, a deformation-reaction force property (rectangle mold) small and lightweight, and ideal is realizable. Like (1) type, namely, when path clearance C is larger than 0 By the 1st tubed part material 1 of a minor diameter being able to enter into the inside part of the 2nd tubed part material 2 of a major diameter, and being able to generate continuous plastic deformation smoothly, and making C x(T1+T2) 1.2 or less path clearance The bend radii R1 and R2 of the member in the case of the plastic deformation shown in drawing 2 can become small, big plastic deformation can occur, and absorbed energy can be raised by it. Moreover, by filling T2/T1>0.8, as shown in (2), the 1st tubed part material 1 of a minor diameter can be made to transform preferentially, the difference of the initial peak load of the moment of colliding, and an average collapse load becomes small, and an ideal square wave can be realized.
[0016] Although it is desirable that it is a cylinder as for the 1st and 2nd tubed part material 1 and 2, a cross-section configuration may be the thing of an ellipse or a polygon.
[0017] The collision energy-absorbing structure 10 can be formed by machining from the same material (one shaping). Moreover, it can manufacture more cheaply by joining the 1st tubed part material 1 and the 2nd tubed part material 2 by welding etc.
[0018] Also in any in shaping and junction, although the board thickness T2 of the 2nd tubed part material 2 may be the same as the board thickness T1 of the 1st tubed part material 1, differing is really desirable. The impact-absorbing property which could carry out that it is easy to make the 1st tubed part material 1 of a minor diameter transform preferentially, and was excellent can be acquired by changing the thickness T1 and T2 of these tubed part material 1 and 2.
[0019] Although especially the ingredient that constitutes the collision energy-absorbing structure 10 is not limited, as an object for automobile car bodies, level on the strength is 270-1500MPa, and the steel which has sufficient ductility which is not fractured at the time of deformation is desirable. Moreover, when residual gamma steel (for example, level on the strength is 590MPa(s)) is used as an ingredient which constitutes the collision energy absorption structure 10, it is the ingredient which has high work-hardening ability, yield strength is low, since it is an ingredient with high plastic deformation reinforcement, by using this ingredient, the deformation in early stages of a collision becomes easy, and an initial peak load can be lessened. If deformation progresses, the reinforcement of an ingredient will rise with work hardening and a high average load will be generated. Consequently, an initial peak is low and can realize an ideal square wave with high absorbed energy. Furthermore, since residual gamma steel has high ductility, it can make small danger of the ingredient fracture at the time of deformation.
[0020] Although the same quality of the material is sufficient as the 1st tubed part material 1 and the 2nd tubed part material 2 when forming the 1st tubed part material 1 and the 2nd tubed part material 2 by junction, it is desirable to consist of the different quality of the material, especially the quality of the material from which level on the strength differs. Thus, even if the board thickness T1 of the 1st tubed part material 1 and the board thickness T2 of the 2nd tubed part

material 2 are the same by changing the quality of the material of these tubed part material 1 and 2, it can carry out that it is easy to make the 1st tubed part material 1 of a minor diameter transform preferentially, and the outstanding impact-absorbing property can be acquired. For example, it is referred to as T1=T2, the SPCC material of on-the-strength level 270MPa is used as the quality of the material of the 1st tubed part material 1 of a minor diameter, and SPFC440 of on-the-strength level 440MPa is used as the quality of the material of the 2nd tubed part material 2 of a major diameter. Thus, by using steel with high level on the strength, board thickness can be reduced and lightweight-ization of components can be realized.

[0021] As for the 1st tubed part material 1 and the 2nd tubed part material 2, it is more desirable that board thickness differs from both quality of the material (level on the strength) putting the above points together.

[0022] As shown in drawing 3 , after producing the 1st tubed part material 1 and the 2nd tubed part material 2 as technique in the case of joining the 1st tubed part material 1 and the 2nd tubed part material 2, welding these by arc welding etc. is mentioned. Moreover, as shown in (a) of drawing 4 , after welding the material tubing 11 and 12 by arc welding etc. first, as shown in (b), a predetermined configuration can be processed with press forming, hydro form, etc., and the 1st tubed part material 1 and the 2nd tubed part material 2 can also be formed. In addition, drawing 4 and the reference mark 5 in drawing 5 show the arc welding section.

[0023] Furthermore, as the 1st plate 13 and 2nd plate 14 are compared as shown in (a) of drawing 5 , and shown in (b) The 1st plate 13 and 2nd plate 14 for example, after welding with the laser-welding machine 15 (-- c --) -- being shown -- as -- tubed -- processing it -- shaft orientations -- for example, -- laser welding -- carrying out -- (-- d --) -- being shown -- as -- an element tube -- 13 -- ' -- and -- 14 -- ' -- a zygote -- ** -- carrying out -- As furthermore shown in (e), a predetermined configuration can be processed with press forming, hydro form, etc., and it can also consider as the zygote of the 1st tubed part material 1 and the 2nd tubed part material 2. In addition, in drawing 5 , a reference mark 16 shows the laser-welding section.

[0024] Although the above collision energy-absorbing structures can consider various application, they show the example applied to the automobile car body at drawing 6 . In drawing 6 , the automobile car body 20 has the frame structure, and the collision energy-absorbing structures 30 and 40 of this invention are arranged, respectively between a side member 21 and bumpers 22 and in the middle of a side member 21. While absorbing efficiently the collision energy at the time of a head-on collision and preventing damage on a car body as much as possible by this, the car body structure which can make whenever [to crew / impact] small is realizable. In this case, gradual collision energy absorption can be performed by making the level of an ingredient on the strength differ by the collision energy absorption structures 30 and 40.

[0025] Next, the result which carried out simulation as compared with the case where the cylinder which does not have a level difference in the engine performance of the collision energy-absorbing structure of this invention is used is explained. Here, simulation was performed using general-purpose finite-element-analysis software. Simulation set level of an ingredient on the strength to 300MPa(s), changed various the paths and board thickness of tubed part material, and was performed.

[0026] Drawing 7 is drawing showing deformation mode. With [which set the path of 40mmphi and the 2nd tubed part material to 45mmphi, and set board thickness to 1.6mmt(s) for the path of the 1st tubed part material as the structure of this invention here] a stage It came and considered as the thing of structure, and the thing of the straight structure which set the path to 40mmphi and set board thickness to 1.6mmt(s) as the comparative structure. In addition, drawing 7 shows

only the one half of a member.
[0027] As shown in this drawing, in the structure of this invention, it turns out that plastic deformation has arisen continuously only in the level difference part to which two tubed part material was joined. On the other hand, with comparative straight structure, it turns out that plastic deformation has arisen in two or more parts near the both ends of a member.
[0028] The relation between the load stroke in this case, reaction force, and absorbed energy is shown in drawing 8 . As shown in drawing 8 , although total absorbed energy is equivalent in the case of a comparison [this invention and], the behavior of reaction force completely differs in both. First, risk of big reaction force acting at the moment of a collision in a comparison, and the impulse force damaging other structures, or shocking crew is large. Moreover, since reaction force is swaying greatly also at the time of subsequent member deformation, the impact to crew comes size too, and it is a pile. Therefore, it turns out that the effectiveness which eases whenever [impact] is small. On the other hand, in the case of this invention, the reaction force of the moment of a collision is small, and change of the reaction force at the time of member deformation is very small to it. For this reason, the danger of damaging other structures in the case of a collision, and the impact to crew can be made remarkably small.
[0029] Next, the 1st and 2nd paths D1 and D2 and board thickness T1 and T2 of tubed part material were changed variously, simulation was performed, and absorbed energy and absorbed energy / weight was found. The result in the case of the simulation is shown in Table 1, and the value of the absorbed energy/weight in the case of the various paths D1 and D2 and the combination of board thickness T1 and T2 is shown in drawing 9 . The black dot of the mark among Table 1 and drawing 9 shows the thing of the desirable range which fills the above-mentioned formula (1) and (2). By filling the above-mentioned formula (1) and (2) from this result, the absorbed energy per weight was large and it was checked that the property which was excellent as an impact-absorbing member is shown.
[0030]
[Table 1]

[0031]
[Effect of the Invention] Since the 1st and 2nd tubed part material from which a path differs mutually has the structure unified in same axle where those edges are put together according to this invention as explained above, the stable reaction force which it is prevented that big buckling reaction force occurs at the moment of colliding, and does not have a periodic change at the time of member deformation can be generated. Therefore, the damage to other members in the case of a collision can be mitigated, and impulse force to crew can be made small. Moreover, since the member of a major diameter can function as a guide and can limit a motion of the member of a minor diameter only to abbreviation shaft orientations among the 1st and 2nd tubed part material, even if the collision direction changes, there is little change of a deformation condition. Therefore, the engine performance powerful [in the direction which collides] and stabilized can be demonstrated, and a reliable design is attained.

[Translation done.]